

OBSERVATIONS ON REARING AND PROTANDRY OF *BANKESIA DOUGLASII* (STAINTON) (LEP.: PSYCHIDAE)

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Abstract. Observations on rearing and protandry of *Bankesia douglasii* (Stainton) (Lep.: Psychidae) are documented over two generations.

INTRODUCTION

On 19.i.1999 I received 12 cases of *Bankesia douglasii* from Dennis O'Keeffe who had collected them from the wall of a workshop in Fareham, Hampshire two days before. I was interested in the potential of *B. douglasii* as a candidate for biomonitoring air pollution.

On inspection I found that the pupae had already hatched, as evidenced from the dried remains of several apterous female moths amongst the debris. As the females of this species oviposit in their old larval cases I retained the cases hoping they contained fertile eggs. I was encouraged when, amongst the debris in the box, I found 10 or so loose eggs. These were pale yellow/white, oval in shape and without any obvious sculpturing of their soft chorion. On 20.iii reddish-brown head capsules of the developing larvae were visible within the loose eggs and on 25.iii newly emerged larvae were found amongst the old cases. By the 28.iii a total of around 220 larvae had emerged from nine female cases, an average of approximately 25 larvae per female.

METHODS

Initially the newly emerged larvae were placed in a perspex box with the old female moth's cases that they had emerged from. I added some powdered garden soil, which was pale orange in colour, and the larvae immediately started to construct miniature cases from this material. Even at this early stage the cases were clearly triangular in cross-section, but with the rear third to one half constructed from the creamy white hairs of the female moth's anal scale tuft, which had been deposited along with the eggs. So they were very obvious at this stage. After a few days I transferred the larvae to a larger box containing a 1 cm layer of sieved John Innes No. 3 potting compost, a much darker material than the soil with which they had commenced case building. I added food to these boxes in the form of dead dry Lepidoptera and algae (*Desmococcus* sp.) on oak bark. Little interest was shown in these, so moist yellow grass cuttings from my lawn were added a day or so later. The larvae showed some interest in this, though I suspect this was more for the moisture it contained than for sustenance. Consequently I gave them a light spray of water, droplets of which they were seen to drink. Thus, spraying was continued periodically throughout the period of culturing.

Being concerned over the lack of visible feeding signs, I asked Dennis O'Keeffe about their habitat and the possible foods present there. He informed me that the only material available was organic debris amongst grass at the foot of their wall, so I gathered such from my lawn, including moss, dandelion leaves and dead grass. I added this material to the culture box in discrete piles to see if the larvae fed preferentially on one or other type. Although no obvious preference was noted at

first, later that day I observed several larvae protruding from their cases and feeding, chiefly on moss. Their guts contained green material so feeding had been established.

On 31.iii I noted that dead fresh Diptera (*Eristalis* sp. adults) I had added a few days before were being consumed. A yellow crusty lichen (*Xanthoria parietina*), found growing on dead blackthorn and oak twigs at Lower Earley (Reading), was then provided and this was avidly consumed. At this time larvae were also feeding, but to a lesser extent, on moss, algae (*Diplococcus viridis*) and dead fresh insects. They were ignoring fresh and dry grass cuttings and wilted dandelion leaves. However, their preferred food was clearly *X. parietina*. By 4.iv some larvae began to excise the hair-scale portions of their cases that were still present and often contained many frass pellets. By 8.iv all larvae had done this.

Second instar larvae were first seen on 11.iv.1999, third instars on 29.iv and fourth instars on 14.v. Final (fifth) instar larvae were present on 2.vi. Instars were assessed on the basis of the size of the larval head capsule. During growth the larvae enlarged their cases by slitting these along their corner edges and adding grit and peat all the way round at these points. This was evident as the paler orange garden soil they were initially supplied with, and which was used for early case construction, was present as a light patch positioned centrally and slightly to the rear of each flat side of their triangular cases. This was surrounded by the much darker John Innes potting compost that they had used subsequently.

By 5.vii the larvae had fixed their cases loosely to the undersides of pieces of bark or the angle of the box lids and remained in this position in a state of aestivation. One case was opened on 9.vii and was found to contain a healthy larva. On 23.ix perambulating larvae were observed, so more *Xanthoria* lichen was added and feeding on this resumed. The lichen material was collected from local stone walls and no doubt accounted for the rapid growth of these larvae compared with those of other species of Psychidae I have reared. By 29.ix many larvae were seen climbing the walls of their culture boxes and fixing their cases firmly in the corners and angles of the lids with white silk. Unusually (compared with other members of this group I have reared) they chose to fix their cases in tightly packed aggregations of up to 20 or 30 individuals. By 15.x all had fixed their cases and on opening one on 29.x I found it still contained a larva. On 25.xi I opened another case to find it contained a female pupa and on 16.i a male pupa was found in this way. By 16.i both developing adults were clearly visible through their pupal shells but eclosion of the female did not occur until 7.ii. The male failed to emerge.

RESULTS

Moths began to emerge on 27.i and by 13.iii a total of 134 had hatched (75 males and 59 females). A total of 37 cases failed to produce adults and a further 20 or so were given to Mr Colin Hart in early January. Pairing of this species was not difficult, indeed it was hard to prevent. On hatching, males would quickly locate a virgin female by fluttering along the base of the box, presumably following an increasing pheromone gradient. Pairing lasted from 30 minutes to two hours, after which the female immediately commenced ovipositing in her old larval case beneath her extruded pupal exuviae. On completion, hair scales from the female's anal tuft were packed on top of the eggs. Oviposition was usually complete within six hours, after which the female would usually fall from her case. Such females lived for a further two or three days before dying. Males, mated or unmated, lived for 48 hours but were usually too weak to fly after 24 hours. Subsequently, from a total of 6

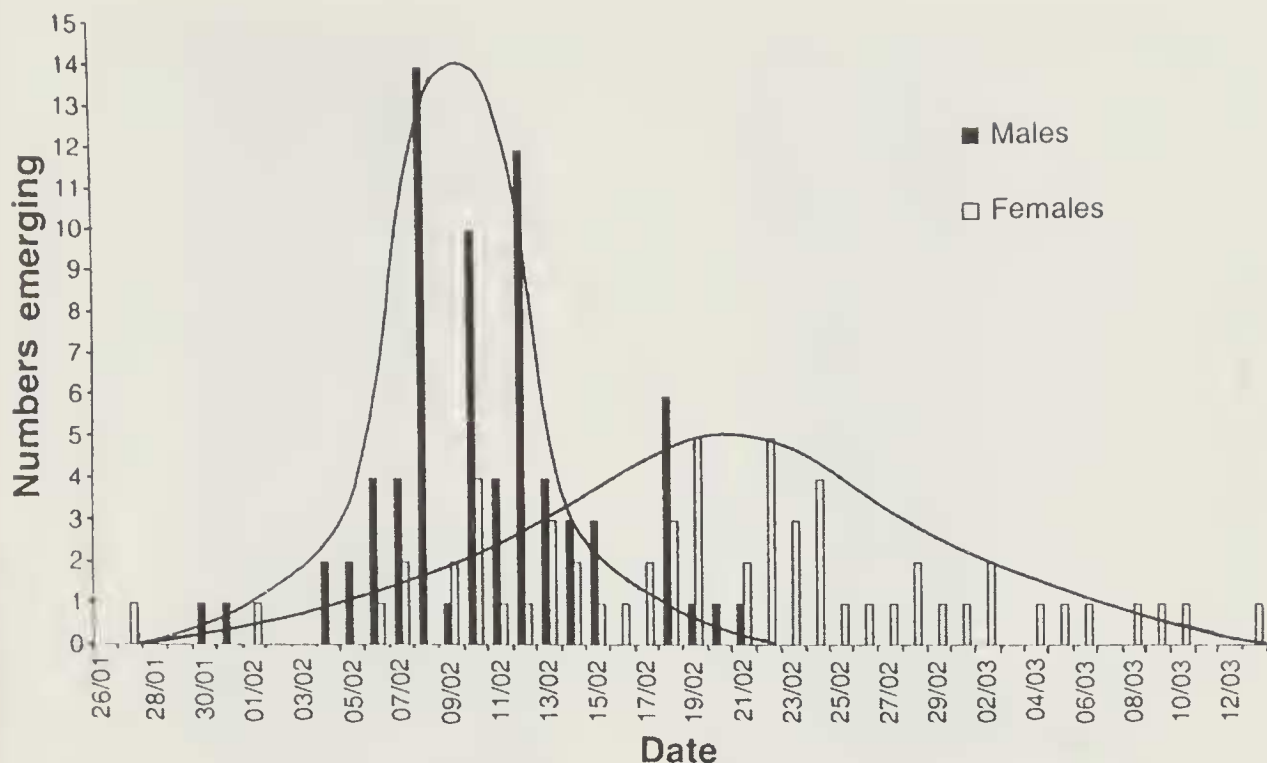


Figure 1. Emergence dates for *B. douglasii*.

paired females. I obtained 171 F_1 larvae between 13–21 March (mean 28). This is approximately the same date of hatching and the same average number of eggs per female as seen with wild material collected by Dennis O'Keefe and suggests that day-length rather than temperature is the environmental trigger dictating adult eclosion with this species. It must be remembered that the environmental conditions these moths were reared under were highly artificial. Despite being cultured indoors throughout their lifecycle the seasonal timing of both larval and adult emergences was not dissimilar to that in nature as the parental stock collected on 17.ii.1999 had all hatched by this date. This is further evidence that the main environmental factor controlling larval growth, pupation and adult eclosion is day-length rather than temperature. The unheated room they were kept in was several degrees warmer than outdoors during the winter months of October to March, but the adult emergence period was unaffected by this.

I made close observations of the emergence times of the adults as they occurred, and noted which sexes were involved. This was a tiring process involving around 170 observations, many made during the early morning and late evening, but produced some useful data. A histogram comparing male and female emergences with date (Fig. 1) shows that the peak of male emergence occurred around 10.ii, approximately 11 days before the peak of female emergence (21.ii). This figure also shows that, for both sexes, the data were normally distributed (note the typical bell-shaped distribution curves). The same data, presented as cumulative percentage emergence against time (a transformation to equalise the proportions of each sex emerging), show that 50% of the males had hatched by 10.ii, while for females 50% hatch was not reached until 9 days later (19.ii). Furthermore, on completion of the male emergence approximately 45% of the females had still to emerge. This is strong evidence of protandry, where males emerge before the females, a common phenomenon amongst the Lepidoptera (Wiklund & Farerström 1977).

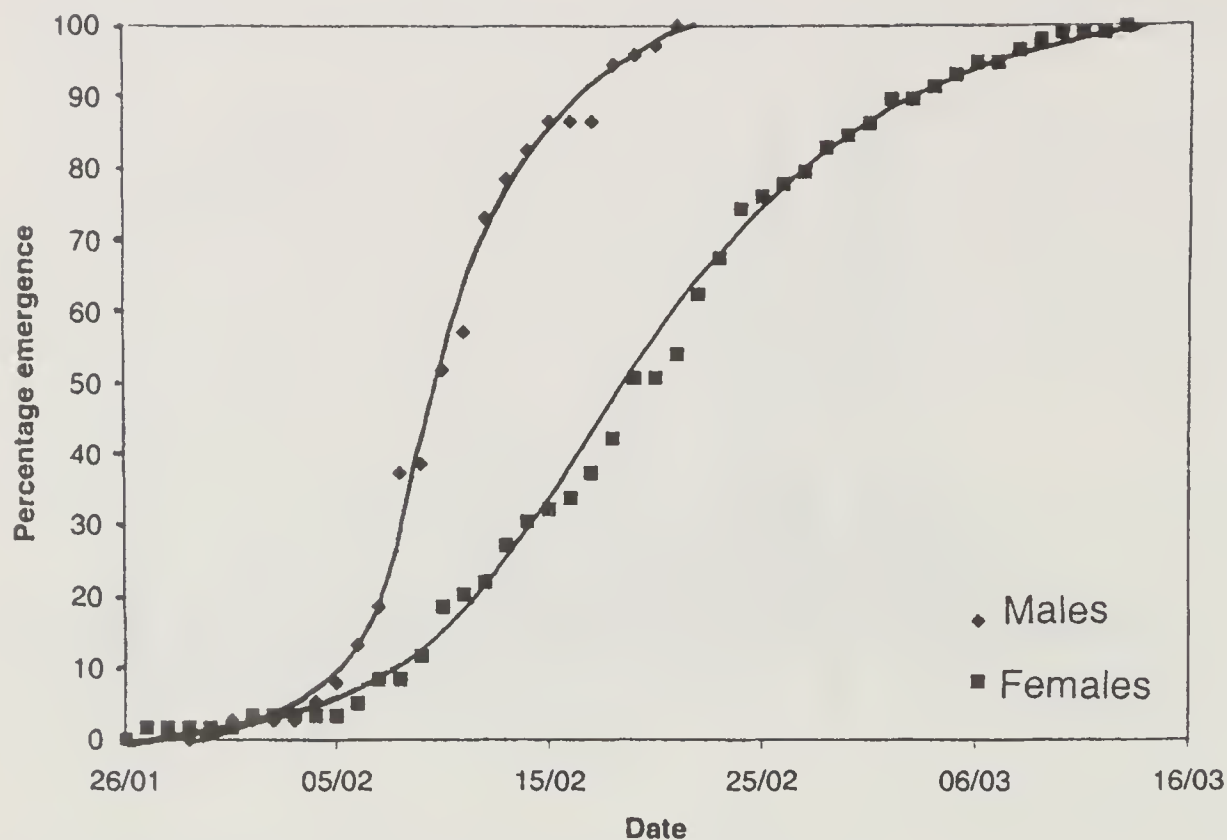
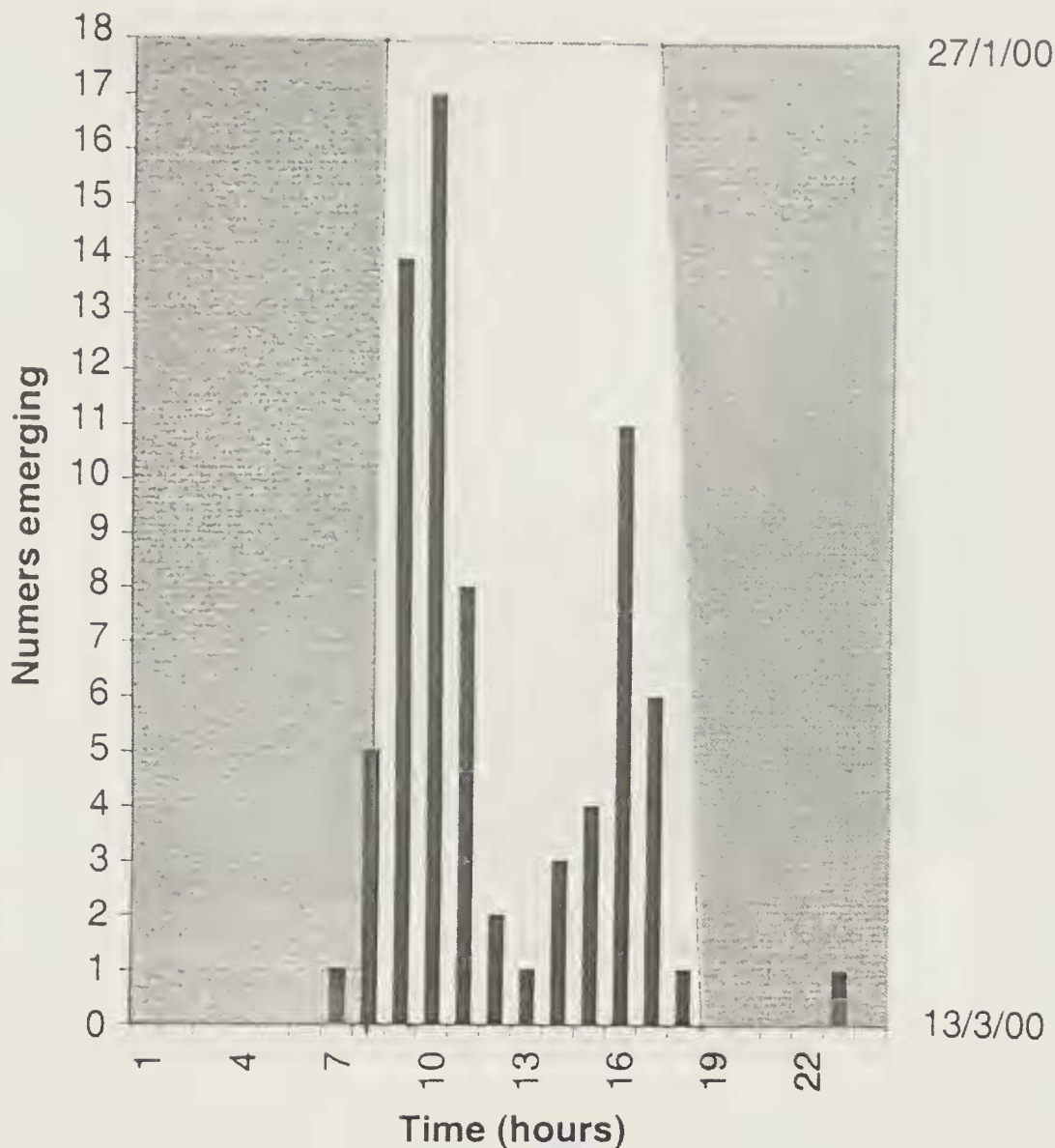


Figure 2. Cumulative percentage emergence of *B. douglasii*, by sex.

DISCUSSION

The times of day when the sexes emerged (Figs 3 and 4) are at variance with the statement of Hättenschwiler (1985) who, commenting on this species, states that males emerge nocturnally and females in the early morning. Males showed two peaks of emergence, both occurring during the hours of daylight. Most emerged in the morning from dawn up to two or three hours later, but there was a second smaller emergence peak in the evening for an hour or two before dark. The pattern of female emergence was different, having a single peak during the two or three hours before dawn. These data should be interpreted with care, as day-length increased over the six-week period covered by these emergences. The times of sunrise and sunset for the Reading area, taken from the GreyStel Star Atlas 2 software package, are included on Figs 3, 4 and 5 to show the extent of this change over the period in question. The hours of darkness are represented as shading. With this information it can be seen that females emerged nocturnally while males emerged during the early morning and late evening, probably in response to changing light intensity. Also, it can be seen that the change in day length over this period was not significant.

The emergence times of female moths during the period when males were emerging (27.i–24.ii) and after male emergence was complete (25.ii–13.iii) differed (Fig. 5). Females emerging with males showed a clear tendency to emerge before dawn, while those emerging after male ecdyses were complete tended to hatch after daybreak. This is a significant observation, though somewhat perplexing. It may explain Hättenschwiler's statement regarding the time of day when female emergence occurs, but the reason for this difference in the timing of female eclosion is difficult to understand. Why should females emerge during the night when males had still to emerge, but by day when all male emergences were complete; and furthermore, how

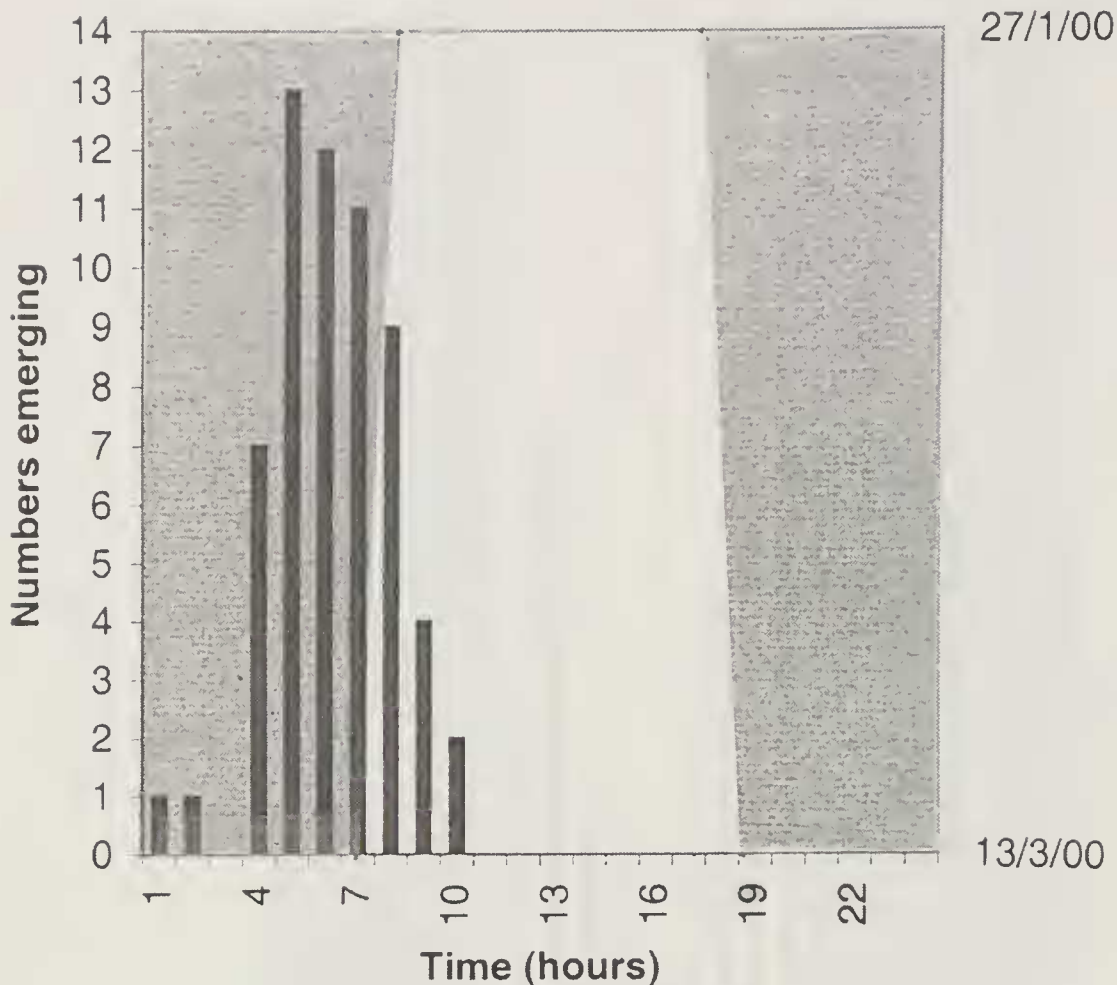


NB - grey areas represent darkness, white area represents daylight

Figure 3. Emergence times for male *B. douglasii*.

did the females know the extent of male emergence? The presence or absence of a male pheromone could be the causative agent of this effect, particularly in the confines of these culture boxes. But could such a substance be potent enough to operate in the wild? The tendency of larvae to fix their triangular (in cross-section) cases prior to pupation in tight aggregations, packing them together like segments of an orange, would enhance the potency of such a chemical message, if this is the factor responsible for this effect. However, not having observed the pre-pupation case-fixing behaviour of this species in the wild, I am unable to comment on the significance of this in the natural environment.

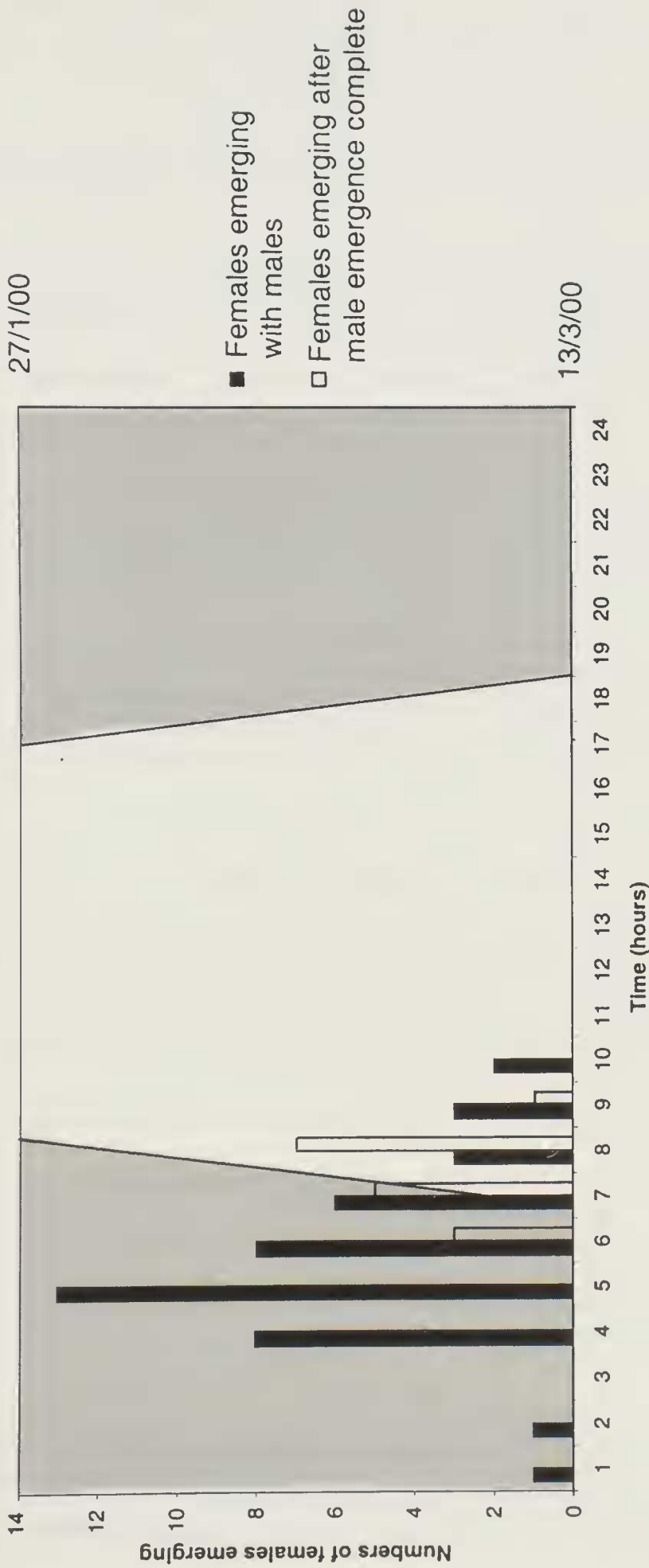
One possible evolutionary advantage of this protandry strategy may be postulated if we accept the theory of metapopulations, whereby populations of a species may exist in discrete colonies separated from each other by some considerable distance. With isolated populations there is a danger of inbreeding resulting in a weakened gene pool. Gene mixing between such pockets of individuals could be increased if the emergence



NB - grey areas represent darkness, white area represents daylight.

Figure 4. Emergence time for female *B. douglasii*.

times of the sexes were slightly different between different populations. In a given population, females emerging with males would stand a better chance of pairing with the freshly emerged males if they hatched a few hours before the males, i.e. assuming the males emerged around dawn there would be an advantage for females to emerge a few hours before dawn. However, let us suppose that all the males of population A have hatched but that some females (perhaps up to 40% as seen here) have yet to emerge. We have seen that males of this species live for only a couple of days, hence those females hatching more than 3 or 4 days after the last male (Fig. 1) would be destined to remain unmated and die without ovipositing. However, if a second population (population B) still has males emerging several days after the males of population A have finished, B's males could, theoretically, mate with A's virgin females, assuming that they could find them. The strong attraction of males to the female pheromone is well known in this family of Lepidoptera and was observed while culturing this species. Pheromone attraction of males to females would be a mechanism which could enable population B's males to locate A's females over considerable distances, and would result in increased genetic diversity in population B. Obviously, with most of A's males moribund and probably incapable of flight it would be advantageous for A's virgin females not to delay hatching until the hours of darkness, i.e. until the following night. Rather, one would expect them to hatch coincidental with



NB - grey areas represent darkness, white area represents daylight.

Figure 5. Female emergence against time, while males emerging and after full male emergence.

the emergence of B's males, i.e. at or just after dawn, release their pheromone and trust that this assembles B's freshly emerged males to them.

This is a somewhat convoluted argument, but it has its attractions. The isolated nature of known UK populations of *B. douglasii* fit this model well, its distribution (MBGBI 2, 1985) being Hampshire, Worcestershire and both vice-counties of Kent. However, in view of the large distances between these areas it is doubtful whether we should consider these colonies as a metapopulation in the sense of our theoretical A and B colonies.

A further occurrence of note occurred with the emergence of the F₂ generation. Protandry was again in evidence, as out of a total of 30 males emergences, 29 (96.7%) occurred between 25.i–20.ii, while all the female emergences occurred between 21.ii and 10.iii.2001. However, it is interesting to note that the total number of F₂ females involved was only 3, and that one of these (33%) emerged many days after the last male had died. The biasing of the sex ratio of psychids has been reported before, see for example Baker's entry for *Psyche casta* (Baker, 1994). However, this is usually in favour of the female sex. I am not aware of an almost exclusive male emergence being reported with any members of this group.

It would be interesting to learn of others' experience in rearing this moth, especially if there are data concerning the emergence dates and sex ratios for wild pupae.

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SHORT COMMUNICATION

***Dipogon bifasciatus* (Geoffroy in Fourcroy) (Hym., Pompilidae) in Derbyshire.**—A spider wasp was found investigating the nooks and crannies in the rugged bark of an ancient open-grown parkland oak in Alderwasley Park (SK336527), Derbyshire, 31.vii.2001. The specimen was sent with a batch of aculeates to Mike Edwards for identification. It proved to be *Dipogon bifasciatus*, a species listed in the British Red Data Book as "Rare" in Shirt (1987) and Falk (1991), and having a very southern distribution—Suffolk and Bedfordshire the counties furthest north with confirmed records.

Alderwasley Park is an old deer park on the plateau behind the National Trust's Shining Cliff Woods, overlooking Crich Chase in the Derwent valley to the south of Matlock. The general area includes a substantial number of ancient open-grown oak trees—relicts of an earlier landscape.

Thanks to Mike Edwards.—K.N.A. ALEXANDER, 14 Partridge Way, Cirencester, Gloucestershire GL7 1BQ.

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